**Lesson 2:** Technologies to Study Brain Function

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**LESSON OVERVIEW**

**Activity Time:**

One 50 minute class period. Additional time for homework.

**Lesson Plan Summary:**

In this lesson, students will first watch a video on the concept of connectome which is described at five different levels. Students will break into groups for a jigsaw activity and then present their findings on other technologies listed.

**STUDENT UNDERSTANDINGS**

**Investigative Phenomenon/Problem:**

* **Description of Phenomenon/Problem:** “The brain is the most complex part in the human body. This three-pound organ is responsible for our intelligence, interpreting sensation, initiating body movement, and controlling all of our behaviors” ([BrainInitiative.org](https://www.braininitiative.org/why-study-the-brain/#)). Scientists all over the world have devised many different and powerful technologies to study the brain such as EEG, fMRI, ECoG, etc. However, our knowledge about how this complex organ allows us to think, form memories and maintain homeostasis is vastly incomplete.
* **Driving Questions:** 
  + How do you study brain function?
  + How may we explore and evaluate different technologies used and what type of information can we get from them?

**Learning Objectives:**

*Students will know…*

* Different biomedical technologies which enable us to study some aspects of brain function or as diagnostics for various diseases such as epilepsy, Alzheimer’s, etc.

*Students will be able to…*

* Compare the pros and cons of different technologies used for studying the brain including the biological level/scale at which brain function is quantified and any limiting factors present.

**Vocabulary**:

* **Action potential:** The nervous system’s communication method is via action potentials, which are electrochemical changes that originate in neurons, are propagated down their axons, and elicit a corresponding response in the adjacent neurons.
* **Brain:** An organ contained in the skull that functions as the body’s command center. The brain, along with the spinal cord, is part of the central nervous system. It controls movement, functions, sensations, memory, and thoughts. The brain can be thought of similarly to an electric circuit, where sensory neurons receive input, the brain processes this, and motor neurons instigate a response.
* **Electroencephalography (EEG):** Non-invasive method used to take recordings from the brain using an electrode array placed on the scalp, with the benefit that no surgery is needed.

**Next Generation Science Standards:**

This lesson builds toward the following Performance Expectation (PE) and its integrated three dimensions of learning. Additional dimensions are denoted with an asterisk (\*).

| **High School Performance Expectations** | | |
| --- | --- | --- |
| [**HS-LS1-1**](https://www.nextgenscience.org/pe/hs-ls1-1-molecules-organisms-structures-and-processes) **From Molecules to Organisms: Structures and Processes**  Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.  [**HS-LS1-2**](https://www.nextgenscience.org/pe/hs-ls1-2-molecules-organisms-structures-and-processes) **From Molecules to Organisms: Structures and Processes**  Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. | | |
| **Science and Engineering Practices (SEPs)** | **Disciplinary Core Idea(s)** | **Crosscutting Concepts (CCCs)** |
| Constructing Explanations and Designing Solutions    Developing and Using Models  \*Asking Questions and Defining Problems | LS1.A: Structure and Function  \*ETS1.A: Defining and Delimiting an Engineering Problem \*PS3.A: Definitions of Energy | Structure and Function  Systems and System Models  \*Energy and Matter  ***Connections to Engineering, Technology, and Applications of Science***  \*Science is a Human Endeavor |

**Common Core State Standards:**

* **CCSS.ELA-LITERACY.RST.11-12.7:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
* **CCSS.ELA-LITERACY.RST.11-12.9:** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
* **CCSS.ELA-LITERACY.RST.11-12.10:** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
* **CCSS.MATH.PRACTICE.MP4:** Model with mathematics. (They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas.)

**TEACHER PREPARATION**

**Materials:**

| **Material** | **Description** | **Quantity** |
| --- | --- | --- |
| Classroom Computer | Teacher computer with projector, speakers, and internet connection to project slideshow and videos | 1 |
| Supplies | Student chromebooks with internet access for the jigsaw activity | 1 per lab member/group |
| Documents | Slidedeck for Lesson 2.  Student Handouts for Lesson 2: Graphic organizer “[Technologies to study the brain and its function](https://docs.google.com/document/d/1nwDgTAo-WlIaINFJxMpyueYO_zxQooUa/edit)”to be completed as a part of the jigsaw activity. | 1 per student |

**Preparation:**

1. If needed, modify the graphic organizer on the student handout by adding or deleting any technologies according to the class size.
2. Make copies of Student Handout for the jigsaw activity.
3. Become familiar with the available resources and the technologies listed.
4. Review the slide deck and modify it if needed.

**PROCEDURE**

*Use the Lesson 2 slide deck as you progress through the lesson procedure.*

**Activity 1: Review/Bridge (5 min)**

1. First review the action potential steps discussed in the last lesson and remind students that action potential is due to the influx of positive ions such as Na+ and K+ through specific ion channels. This can be done by projecting or drawing the diagram of action potential on a whiteboard and adding in the details as the review progresses.
2. Lead a class discussion by asking students if they are aware of any technologies used to study the brain function. Student answers may be limited to EEG or MRI or CT scans.
3. Cue the students to the first video in Activity 1 by informing them that brain function can be studied at a molecular level (action potential), cellular (action potential, synapses) and also as a whole by detecting electrical impulses like EEG.

**Activity 2: What are the available biomedical technologies to study brain function? (10 min)**

1. Using the slide deck, have students watch a video discussing one such technology - Connectome.

**Neuroscientist Explains One Concept in 5 Levels of Difficulty**

WIRED March 7, 2017 | YouTube (9:42 minutes)

Closed captioning available

<https://www.youtube.com/watch?v=opqIa5Jiwuw> 9m42s

1. Divide the students into groups and assign them one technology (6 total) to research and answer the questions.

**Activity 3: Student Led Research - Jigsaw (15 minutes)**

*Note: This can be assigned as homework.*

1. Each technology has beginner and advanced resources to start the students and they can use any other resources they find (see handout). Students do not require to read the advanced resource in detail and assure them that it is not necessary to understand every detail mentioned.
2. Teachers should be well versed with these technologies so that they can circulate and guide student groups needing additional help. Teachers can modify the graphic organizer by adding or deleting any technologies according to the class size. Check for progress of student groups and presentations can be done either by Google slides or in a shared Google Doc.

**Activity 4: Group Presentations (15 minutes)**

1. Allow time for each student group to present to the class on their topic. As each group presents, the student groups who are making up the audience should fill in their graphic organizer.
2. Check for completion of the graphic organizers while students work on their exit ticket.

**Activity 5: Exit Ticket (5 minutes)**

1. Please see the slide deck for Lesson 2 for an example.

**STUDENT ASSESSMENT**

**Assessment Opportunities:**

* Filled in graphic organizer
* Student group presentations
* Exit ticket

**DIFFERENTIATION FOR INCLUSIVE INSTRUCTION**

**Adaptations for Remote Learning Environments:**

| **Name of Activity** | **Remote Adaptations** |
| --- | --- |
| **Activity 1** | Discussion via Zoom or Google Meet, including use of digital whiteboard. |
| **Activity 2** | Video played on Zoom or Google Meet. |
| **Activity 3** | Breakout rooms. Graphic organizer put in as an assignment on Google Classroom. |
| **Activity 4** | Student presentations on Zoom or Google Meet. |
| **Activity 5** | Exit ticket submitted via email or LMS. See example in the Lesson 2 slide deck. |

**Adaptations for Learners’ Needs:**

* The initial video has closed captioning available and is explained at five different levels, from a 5 year old to a research scientist.
* Each technology has beginner and advanced resources to start the students and they can use any other resources they find (see handout). Teacher can remove these links or add additional resources.

**Extension Activities to Build on Student Interest and Expertise:**

* NSF Brain Initiative’s YouTube channel has curated videos on many different neuroscience topics: <https://www.youtube.com/user/NSFbraininitiative>

**TEACHER BACKGROUND & RESOURCES**

**Background Information:**

The URLs in the graphic organizer are a great resource for the relevant background. YouTube also has many videos on the technologies which are easy to understand.

**Additional Resources:**

# EEG and Action Potentials:

<https://www.youtube.com/watch?v=86zIa3pGM50> 6m

Teachers can also watch these online resources from Yale:

Lecture 20 - Bioimaging <https://oyc.yale.edu/biomedical-engineering/beng-100/lecture-20>

Lecture 21 - Bioimaging (cont.) <https://oyc.yale.edu/biomedical-engineering/beng-100/lecture-21>